

What is claimed is:

1 1. A process for imprint lithography comprising the steps of:
2 orienting a lithographed template and a substrate in spaced relation to
3 each other so that a gap is created between said template and said substrate;
4 filling said gap with UV curable liquid that could be dispensed either
5 before or after establishing the gap;
6 curing said UV curable liquid within said gap; and
7 separating said template and said substrate so that a pattern is transferred
8 from said template to said substrate leaving desired features thereon.

1 2. The process of claim 1 further comprising the step of treating the
2 template with a low surface energy monolayer to assist in separation;

1 3. The process of claim 1 wherein said filling step is performed by
2 controllably dispensing said UV curable liquid between the template and
3 substrate, or spin coating said UV curable liquid on the substrate.

1 4. The process of claim 3 wherein said liquid dispensing step is performed
2 without forming bubbles within said gap.

1 5. The process of claim 3 wherein said liquid dispensing step is performed at
2 low pressures.

1 6. The process of claim 1 wherein said orienting step is performed so that
2 the gap is approximately uniform across said template and said substrate.

1 7. The process of claim 1 wherein said curing step is performed by exposing
2 said low viscosity liquid to UV light that causes said UV curable liquid to conform
3 to the shape of said template.

4 8. The process of claim 1 wherein said filling step is performed by dispensing
5 a silicon-based monomer or other organic liquids within said gap.

1 9. The process of claim 1 wherein said separating step is performed without
2 shearing any of said desired features from said substrate.

1 10. The process of claim 1 wherein said separating step is performed so that
2 said desired features are transferred to a transfer layer interspersed between
3 said template and said substrate.

1 11. The process of claim 1 wherein said separating step further comprises the
2 step of peeling and pulling said template from said substrate.

1 12. For an imprint lithography process, a system capable of controlling the
2 relative orientation and the relative gap between the template and substrate;

3 by allowing high-resolution orientation to be performed about axes that lie
4 at the template-substrate interface

5 by allowing high resolution translation normal to the template-substrate
6 interface

7 by processing high stiffness in directions that can result in shearing of
8 imprinted structures.

13. The system of claim 12 capable of calibrating and orienting a template with respect to a substrate surface to be imprinted comprising:

a pre-calibration stage for course movement and alignment of a template with respect to a substrate surface so that a gap is created between said template and said substrate surface; and

an orientation stage used in conjunction with said pre-calibration stage for fine movement and alignment of said template so that said gap is approximately uniform across that portion of said template that lies over said substrate surface.

14. The system of claim 13 wherein said orientation stage further comprises:

a first orientation sub-stage for moving and aligning said template about a first orientation axis; and

a second orientation sub-stage for moving and aligning said template about a second orientation axis.


15. The system of claim 14 wherein said first orientation sub-stage and said second orientation sub-stage are arranged so that said first orientation axis is orthogonal to said second orientation axis.

16. The system of claim 14 wherein said first orientation sub-stage and said second orientation sub-stage are further arranged so that said first orientation axis and said second orientation axis lie along template-substrate interface.

1 17. The system of claim 14 wherein:

2 said first orientation sub-stage further comprises a first flexure member
3 having a first plurality of flexible joints for causing said first flexure member to
4 rotate about said first orientation axis; and

5 said second orientation sub-stage further comprises a second flexure
6 member coupled to said first flexure member and having a second plurality of
7 flexible joints for causing said second flexure member to rotate about said
8 second orientation axis.

1 18. The system of claim 17 wherein said second orientation sub-stage further
2 includes a support for securing said template. 

1 19. The system of claim 17 wherein said first plurality of flexible joints include
2 four flexure joints predisposed about said first orientation sub-stage to cause its
3 motion about said first orientation axis.

1 20. The system of claim 17 wherein said second plurality of flexible joints
2 include four flexure joints predisposed about said second orientation sub-stage to
3 cause its motion about said second orientation axis.

1 21. The system of claim 17 wherein said first flexure member and said second
2 flexure member are configured to cause said first orientation flexure member and
3 said second orientation member to pivot about a single point of said template
4 when secured in said support, said single point lying in a plane containing both
5 said first orientation axis and said second orientation axis.

1 22. The system of claim 13 further comprising openings within said pre-
2 calibration stage and orientation stage, respectively, for permitting UV light to
3 reach said template-substrate interface.

1 23. The system of claim 13 further comprising:
2 housings supporting both said pre-calibration stage and said orientation
3 stage; and
4 a plurality of actuators extending from said housings for causing said pre-
5 calibration and orientation stages to move.

1 24. The system of claim 13 wherein said plurality of actuators comprise three
2 high-resolution actuators equally spaced apart about said housing of said pre-
3 calibration stage.

1 25. The system of claim 23 wherein said pre-calibration stage comprises first
2 and second disk-shaped members, said first disk-shaped member coupled to an
3 open end of said housing, said second disk-shaped member coupled to said first
4 disk-shaped member opposite said open end, said first disk-shaped member
5 including openings through which said three high resolution actuators extend to
6 said second disk-shaped member.

1 26. The system of claim 25 wherein said orientation stage is coupled to said
2 second disk-shaped member.

1 27. An orientation stage for achieving fine movement and alignment of a
2 27-33 template in an imprint lithography process, said orientation stage comprising:

3 355/72 a first flexure member with first and second arms extending therefrom,
4 each arm including a first set of flexure joints which provide pivotal motion of said
5 first flexure member about a first orientation axis;

6 a second flexure member having third and fourth arms extending
7 therefrom, each arm including a second set of flexure joints which provide pivotal
8 motion of said second flexure member about a second orientation axis; and

9 a support coupled to said second flexure member and adapted for holding
10 a template in place during imprinting;

11 wherein said first and second flexure members are further adapted to be
12 joined so that a template in said support moves about a pivot point intersected by
13 said first and second orientation axis.

1 28. The orientation stage of claim 27 wherein:

2 said first set of flexure joints are parallel to each other; and

3 said second set of flexure joints are parallel to each other.

1 29. The orientation stage of claim 27 wherein said first and second set of
2 flexure joints are constructed of a flexible material.

1 30. The orientation stage of claim 27 wherein each of said first, second, third
2 and fourth arms comprise:

3 a first notch attached to a corresponding flexure member;

4 a second notch for attachment to a fixed object; and

5 a rigid body section extending between said first and second notches.

1 31. The orientation stage of claim 27 further comprising actuators in operable
2 contact with said flexure member to cause said support to pivot about said pivot
3 point.

1 32. The orientation stage of claim 31 wherein said actuators are piezo
2 actuators.

1 33. The orientation stage of claim 32 wherein said piezo actuators are capable
2 of being shortened and lengthened causing said flexure joints to rotate in both
3 directions.

1 34. A vacuum chuck for imprint lithography comprising:
2 34-44 a chuck body having formations extending from it leading to a substantially
3 355/76 flat upper surface for contacting a substrate to be imprinted; and
4 a vacuum flow system extending through said body to said upper surface
5 for creating suction that would hold said substrate in contact with said formations.

1 35. The vacuum chuck of claim 34 wherein said formations comprise a
2 plurality of pins or holes.

1 36. The vacuum chuck of claim 35 wherein the size and spacing between said
2 plurality of pins or holes is optimized based on a set of imprint lithography
3 parameters.

1 37. The vacuum chuck of claim 35 wherein each of said plurality of pins is
2 approximately 0.5 mm in diameter, or spacing between said holes is
3 approximately 0.5 mm.

1 38. The vacuum chuck of claim 35 wherein the spacing between said plurality
2 of pins is approximately 2 mm, or the diameter of said holes is approximately 2
3 mm.

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5 39. The vacuum chuck of claim 34 wherein said formations comprise a
6 plurality of fine grooves circling the area spanned by said upper surface.

1 40. The vacuum chuck of claim 39 wherein each of said plurality of fine
2 grooves forms a straight wall.

1 41. The vacuum chuck of claim 39 wherein each of said plurality of fine
2 grooves has a smooth curved cross section.

1 42. The vacuum chuck of claim 39 wherein said vacuum flow system
2 comprises a plurality of vacuum flow holes extending to said plurality of grooves.

1 43. The vacuum chuck of claim 39 wherein said vacuum flow system
2 comprises a plurality of fine vacuum flow channels extending through multiple
3 grooves in a direction parallel to said upper surface.

1 44. The vacuum chuck of claim 34 wherein said chuck body is fabricated from
2 an optical flat.

1 45. A method of manufacturing a vacuum chuck comprising the steps of:
2 drilling a plurality of vacuum flow holes through an optical flat;
3 applying a patterned mask to an upper surface of said optical flat; and
4 etching said optical flat to form desired formations on said upper
5 surface.

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1 46. The method of claim 45 further comprising the step of treating said upper
2 surface to ensure that said desired formations are clean and rigid.

1 47. The method of claim 45 wherein the step of applying a patterned mask is
2 performed so that a pin or hole pattern is applied to said upper surface.

1 48. The method of claim 45 wherein the step of applying a patterned mask is
2 performed so that said a fine groove pattern is applied to said upper surface.

1 49. The method of claim 48 wherein the step of etching is
2 performed so that said groove pattern leaves formation that consist of straight
3 walls.

1 50. The method of claim 48 wherein the step of etching is
2 performed so that said groove pattern leaves formations that consist of smooth
3 curved walls.

4 51. During imprint lithography that transfers a pattern from a template to a
substrate, a process for separating the template from the substrate to leave
desired features substantially undamaged on said substrate to not move the
substrate, and to reduce separation forces comprising the steps of:

5 applying a first force to begin a peeling separation of the template from
6 the substrate; and

7 applying a second force to achieve a pulling separation of the template
8 from the substrate;

9 wherein said first and second forces are applied to prevent shearing of
10 desired features from said substrate following imprint lithography.

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1 52. The process of claim 51 wherein said step of peeling separation is
2 achieved by inducing a wedge-shaped separation at one end of the template-
3 substrate interface.

1 53. The process of claim 52 wherein said wedge-shaped separation is
2 achieved by holding said substrate in place and tilting said template.

1 54. The process of claim 52 wherein said wedge-shaped separation is
2 achieved by holding said template in place and tilting said substrate.

1 55. The process of claim 52 wherein said wedge-shaped separation is
2 achieved by the additional steps of:

3 inserting an actuator between the substrate and template; and
4 enlarging the actuator to push the template away from the substrate.

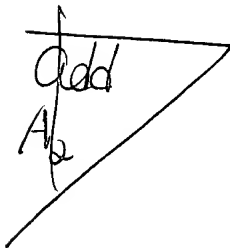
1 56. The process of claim 55 further comprising the step of coating said
2 actuator to prevent sticking of the substrate to the actuator.

1 57. A template holder for imprint lithography comprising a frame that can
2 make surface contact with regions of the side walls of the template and the
3 regions of the back all of the template to allow holding of the template during
4 imprint and separation processes without substantially distorting the template.

1 58. The template holder of claim 57 further comprising the ability to hold the
2 template using one or combinations of mechanical clamping, vacuum force and
3 electro-static methods.

1 59. The template holder of claim 58 wherein said mechanical clamping of is
2 enabled using setscrews, piezo-actuators, pneumatic or hydraulic actuators in
3 conjunction with compliant elements that provide surface contact.

1 60. The template holder of claim 57 wherein the side walls are wedged to form
2 curved shaped side walls that support both imprint and separation forces.



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